On the road to a chiral extrapolation of the generalized form factors of the nucleon

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Theoretische Physik T39

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Treffen der DFG-Forschergruppe “Gitter-QCD”
Universität Leipzig, Germany
Nov 18 -19, 2005

Outline

- The generalized form factors of the nucleon
- Comparison to the <x> data of T. Streuer et al.
- Comparison of $A_{2,0}$, $B_{2,0}$ and $C_{2,0}$ at q^2=0
- First observations on momentum dependence and radii
- Outlook

Generalized Form Factors

- Three generalized form factors (GFFs) in the isovector channel: $A_{2,0}(t)$, $B_{2,0}(t)$ and $C_{2,0}(t)$

$$i\left\langle p'\left|\bar{q}\gamma_{\{\mu,}\overleftrightarrow{D}_{\nu\}}q\right|p\right\rangle_{u-d} = \bar{u}(p')\left[A_{2,0}^{u-d}(t)\gamma_{\{\mu,}\bar{p}_{\nu\}} - \frac{B_{2,0}^{u-d}(t)}{2M_N}\Delta^{\alpha}\sigma_{\alpha\{\mu,}\bar{p}_{\nu\}} + \frac{C_{2,0}^{u-d}(t)}{M_N}\Delta_{\{\mu,}\Delta_{\nu\}}\right]u(p)$$

with

$$\mathrm{t} = \Delta^2 = (p'-p)^2 \quad \text{and} \quad \bar{p} = \frac{1}{2}(p'+p); \quad <x>_{u-d} = A_{2,0}^{u-d}(0)$$

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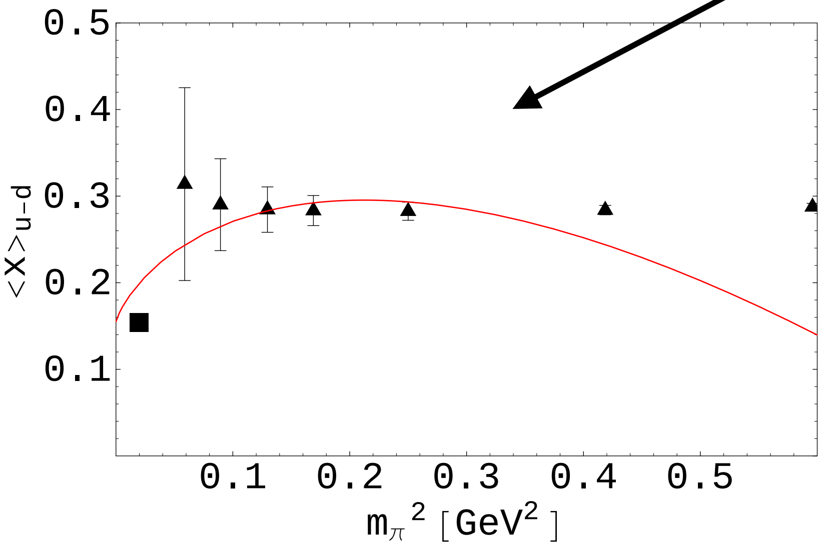
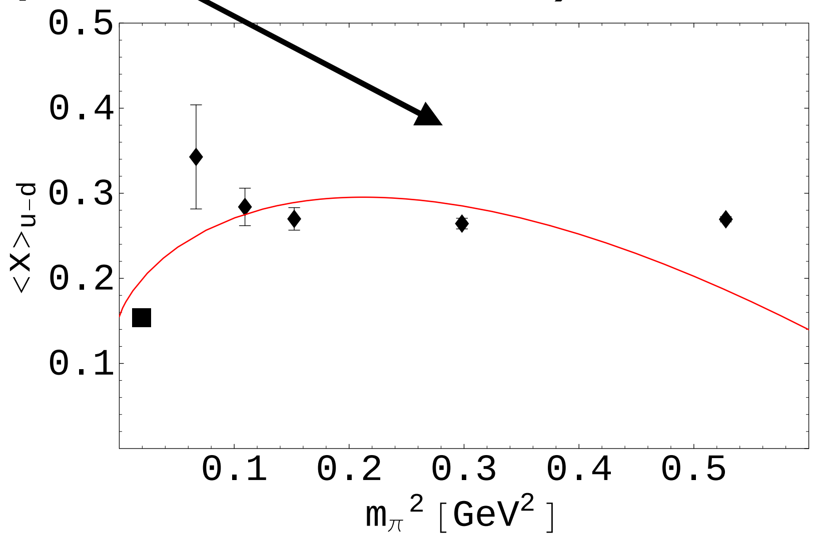
Quenched Data (Streuer et al.)

- Quenched overlap data lie higher than LHPC results: Finite Size Effects ?
- Fit to HBChPT $O(p^4)$ result for <x> looks reasonable (Fit at β=8.0, β=8.45 result ??)





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Differences in the GFFs

- $A_{2,0}$, $B_{2,0}$ and $C_{2,0}$ behave very differently as functions of m_π at small t
- $A_{2,0}(t=0)$ has a chiral log as LNA and plateaus very fast according to the present data situation
- $B_{2,0}$ and $C_{2,0}$ have a term ~ m_π^3 as LNA:

$$B_{2,0}(t=0)=B_{40}\, M_N(m_\pi) + O(p^5)$$

$$C_{2,0}(t=0)=S_{42}\, M_N(m_\pi) + O(p^5)$$

$\rightarrow$ We do not expect that $B_{2,0}(t=0)$ and $C_{2,0}(t=0)$ reach a plateau in m_π as fast as $A_{2,0}(t=0)$!

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Momentum dependence/Radii

- Radii of isovector Dirac/Pauli form factors $A_{1,0}(t)$, $B_{1,0}(t)$, have well-known chiral singularities:

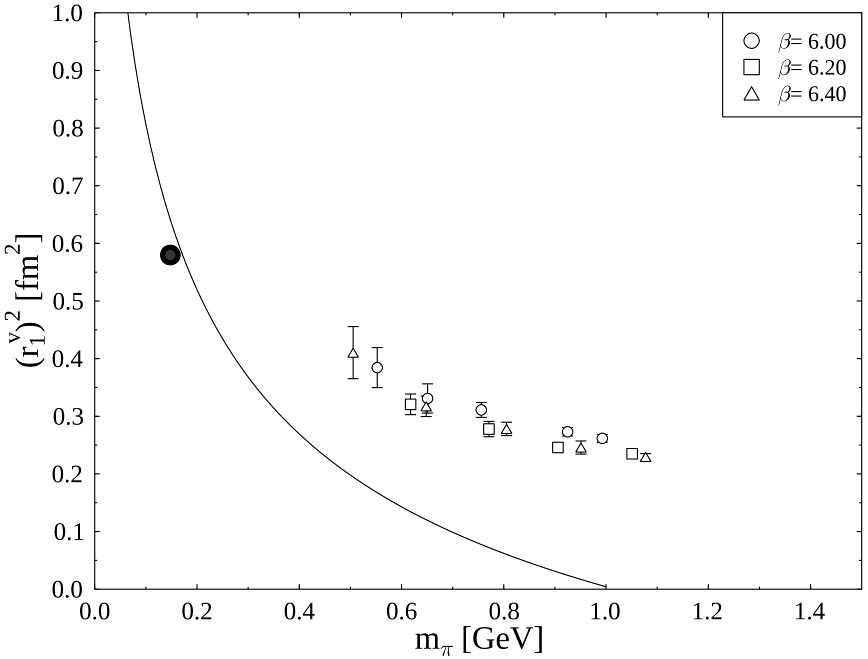
$$r_1 \sim \log m_\pi \,,\; r_2 \sim 1/\, m_\pi$$

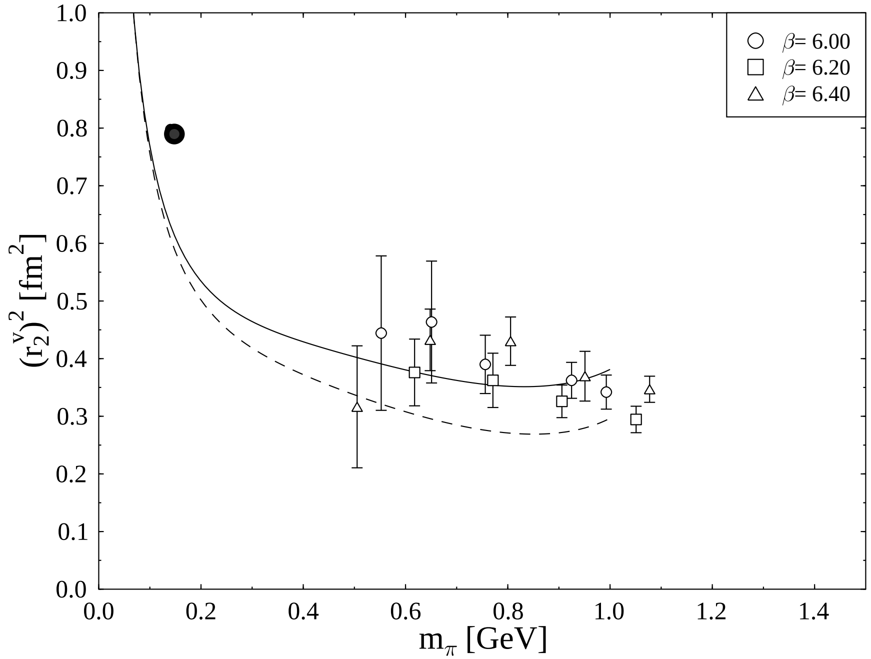
$\rightarrow$ Size of nucleon increases near the chiral limit

- Radius of isovector GFF $A_{2,0}(t)$ stays finite in the chiral limit !!
  - What about the radii of $B_{2,0}(t)$, $C_{2,0}(t)$?

Conclusion: Our global p-pole fits for the GFFs still hide a lot of interesting structures !

Isovector Radii of the Nucleon





Chiral Extrapolation: NR-SSE
Data: Quenched (improved) Wilson fermions
QCDSF collaboration, Phys. Rev. D71, 034508 (2005).

Outlook

- $O(p^4) + O(p^5)$ BChPT calculation for isovector vector and axial-vector GFFs has started (M. Dorati and TRH)
  - 5 + 12 diagrams, in MIR-regularization (T. Gail and TRH, forthcoming), cross-talk of LECs in vector/axial-vector channel
  - Plateau-behaviour for <x> needs to be established first, then calculation of finite size effects possible in a second step
- Numerical comparison of the here presented $O(p^4)$ HBChPT results for $A_{2,0}$, $B_{2,0}$ and $C_{2,0}$ at t=0 with lattice data → Publication